

Amended Claims  
submitted February 2008

- Clm 1. Apparatus for diminishing the concentration of ammonium in waste-water, and for disposing of the ammonium as nitrogen gas, wherein:
- [2] the apparatus includes an ammonium-extraction station, which:-
  - [3] - includes a waste-water entry port, for receiving a stream of the waste-water to be treated;
  - [4] - is operable to extract ammonium out of solution from the waste-water stream;
  - [5] - includes a treated-water discharge port, for discharging the waste-water stream, now with its dissolved ammonium content reduced, from the apparatus;
  - [6] the apparatus includes a body of secondary-water;
  - [7] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
  - [8] the apparatus includes an ammonium-transfer station, which is one of the water-containment components of the secondary-water circuit, and which is operable to receive the ammonium extracted from the ammonium-extraction station, and to transfer same into the body of secondary water;
  - [9] the apparatus includes an electrolysis station;
  - [10] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-
  - [11] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;
  - [12] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
  - [13] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station;
  - [14] the apparatus includes a tank, which is one of the water-containment components of the secondary-water-circuit;
  - [15] the ammonium-transfer station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water respectively enters and leaves the ammonium-transfer station;
  - [16] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water enters and leaves the electrolysis-station;
  - [17] the ammonium-transfer station is so configured that secondary-

water in the ammonium-station-outlet is at a higher concentration of dissolved ammonium than secondary-water in the ammonium-station-inlet;

[18] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of dissolved ammonium than secondary-water in the electrolysis-station-inlet;

[19] the secondary-water circuit includes respective conduits that convey secondary water:-

[20] - from the ammonium-station-outlet into the tank;

[21] - from the tank into the ammonium-station-inlet;

[22] - from the electrolysis-station-outlet into the tank; and

[23] - from the tank into the electrolysis-station-inlet.

Clm 2. Apparatus of claim 1, wherein the apparatus includes means for adjusting the pH level of secondary-water residing in the tank.

Clm 3. Apparatus of claim 1, wherein the apparatus includes a means for stirring secondary-water residing in the tank.

Clm 4. Apparatus of claim 1, wherein the said respective conduits that convey secondary water:-

[2] - from the ammonium-station-outlet into the tank;

[3] - from the tank into the ammonium-station-inlet;

[4] - from the electrolysis-station-outlet into the tank; and

[5] - from the tank into the electrolysis-station-inlet;

[6] are effective to so convey the secondary-water directly.

Clm 5. Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without itself being subjected to electrolysis.

Clm 6. Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without touching the body of secondary-water.

Clm 7. Apparatus of claim 1, wherein the apparatus is operable to circulate and recirculate the secondary-water through the electrolysis station.

Clm 8. Apparatus of claim 1, wherein:

[2] an ion-exchange station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;

[3] the ion-exchange station includes a sorbent-container, in which

- is contained a sorbent-body, which is effective to sorb ammonium from water passing therethrough;
- [4] the secondary-water comprises regenerant-water, being water that contains, in solution, a regenerant-substance, which is of such nature, and of such concentration, as to have an ion-exchange relationship with respect to ammonium ions sorbed onto the sorbent-body, and wherein the secondary-water preferably is brine;
  - [5] the ion-exchange station includes connecting conduits and operable flow-control valves therein;
  - [6] the valves are operable to set the ion-exchange station into a sorption-mode and are operable to set the ion-exchange station into a regenerant-mode;
  - [7] in the sorption-mode, the valves and conduits are arranged so that waste-water passes from the waste-water entry port, through the sorbent-container, and out of the treated-water discharge port; and
  - [8] in the regenerant-mode, the valves and conduits are included in the secondary-water circuit, in which the regenerant-water, having passed through the sorbent-container, passes then through the electrolytic cell.

Clm 9. Apparatus of claim 8, wherein the secondary-water circuit is operable to recirculate the regenerant-water through the sorbent-container and the electrolytic cell.

Clm 10. Apparatus of claim 1, wherein:-

- [2] an alkali-acid station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;
- [3] the body of secondary-water comprises a body of acid-water, and wherein the secondary-water preferably is, or includes, hydrochloric acid;
- [4] the alkali-acid station includes:
  - [5] - a means for elevating the pH of ammonium-laden waste-water entering the waste-water entry port to at least ten;
  - [6] - an alkali-station, comprising a waste-water conduit containing the alkaline waste-water and a gas conduit, and the alkali-station is so structured that ammonia gas emanating from the alkaline waste-water in the waste-water conduit is captured and carried away in the gas conduit;
  - [7] - a means for maintaining the pH of the acid-water at no more than four;
  - [8] - an acid-station, which includes the gas conduit and an acid-water conduit containing the acid-water, and the acid-

station is so structured that ammonia gas contained in the gas conduit is taken into solution in the acid-water in the acid-water conduit;

- [9] and the secondary-water circuit includes the acid-water conduit, in which the acid-water, having passed through the acid-station, passes then through the electrolytic cell.

Clm 11. Apparatus of claim 10, wherein the secondary-water circuit is operable to recirculate the acid-water through the acid-station and the electrolytic cell.

Clm 12. Water treatment plant, for treating both a lower-flowrate stream of higher-concentration waste-water and a higher-flowrate stream of lower-concentration waste-water, wherein:

- [2] the plant is operable to pass the lower-concentration stream through the ion-exchange station of claim 8, and the higher-concentration stream through the alkali-acid station of claim 10;
- [3] and the plant is operable to mix the treated waste-water effluent from the alkali-acid station with the waste-water stream entering and passing through the ion-exchange station.

Clm 13. Apparatus for diminishing the concentration of ammonium in a body of secondary-water, and for disposing of the ammonium as nitrogen gas, wherein:

- [2] the apparatus includes a body of secondary-water;
- [3] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
- [4] the apparatus includes an ammonium station, which is one of the components of the secondary-water circuit;
- [5] the apparatus is so arranged that ammonium is added to secondary-water passing through the ammonium station;
- [6] the apparatus includes an electrolysis station, which is one of the components of the secondary-water circuit ;
- [7] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-
- [8] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;
- [9] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
- [10] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis

station;

- [11] the apparatus includes a tank, which is one of the components of the secondary-water-circuit;
- [12] the ammonium station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water respectively enters and leaves the ammonium-station;
- [13] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water enters and leaves the electrolysis-station;
- [14] the ammonium station is so configured that secondary-water in the ammonium-station-outlet is at a higher concentration of dissolved ammonium than secondary-water in the ammonium-station-inlet;
- [15] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of dissolved ammonium than secondary-water in the electrolysis-station-inlet;
- [16] the secondary-water circuit includes respective conduits that convey secondary water:-
- [17] - from the ammonium-station-outlet into the tank;
- [18] - from the tank into the ammonium-station-inlet;
- [19] - from the electrolysis-station-outlet into the tank; and
- [20] - from the tank into the electrolysis-station-inlet.

Clm 14. Apparatus of claim 13, wherein the body of secondary-water is brine.

Clm 15. Apparatus of claim 13, wherein the body of secondary water is, or includes, hydrochloric acid.

**Amments to Claims**  
submitted February 2008

As-examined claims now amended: 1-3,7,11,12,18,19.

As-examined claims now cancelled: 4-6,8-17.

New claims now added: (none)

- Clm 1 (currently amended).** Apparatus for diminishing the concentration of ammonium in waste-water, and for disposing of the ammonium as nitrogen gas, wherein:
- [2] the apparatus includes an ammonium-extraction station, which:-
  - [3] - includes a waste-water entry port, for receiving a stream of the waste-water to be treated;
  - [4] - is operable to extract ammonium out of solution from the waste-water stream;
  - [5] - includes a treated-water discharge port, for discharging the waste-water stream, now with its dissolved ammonium content reduced, from the apparatus;
  - [6] the apparatus includes a body of secondary-water;
  - [7] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
  - [8] the apparatus includes an ammonium-transfer station, which is one of the water-containment components of the secondary-water circuit, and which is operable to receive the ammonium extracted from the ammonium-extraction station, and to transfer same into the body of secondary water;
  - [9] the apparatus includes an electrolysis station; ~~[which is one of the components of the secondary-water circuit]~~
  - [10] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-
  - [11] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;
  - [12] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
  - [13] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station;
  - [14] the apparatus includes ~~[an intermediate tank]~~ a tank, which is one of the water-containment components of the secondary-water-circuit;
  - [15] the ammonium-transfer station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water respectively enters and leaves the ammonium-transfer station;
  - [16] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water enters and leaves the electrolysis-station;
  - [17] the ammonium-transfer station is so configured that secondary-water in the ammonium-station-outlet is at a higher concentration of dissolved ammonium than secondary-water in the ammonium-station-inlet;
  - [18] ~~[the electrolysis station has an electrolysis-station inlet and an electrolysis-station outlet, through which secondary-water respectively enters and leaves the electrolysis-station];~~
  - [19] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of dissolved ammonium than secondary-water in the electrolysis-station-inlet;
  - [20] the secondary-water circuit includes respective conduits that convey secondary water:-
  - [21] - from the ammonium-station-outlet into the ~~[intermediate]~~ tank;
  - [22] - from the ~~[intermediate]~~ tank into the ammonium-station-inlet;
  - [23] - from the electrolysis-station-outlet into the ~~[intermediate]~~ tank; and
  - [24] - from the ~~[intermediate]~~ tank into the electrolysis-station-inlet.

**Clm 2 (currently amended).** Apparatus of claim 1, wherein the apparatus includes means for adjusting the pH level of secondary-water residing in the ~~[intermediate]~~ tank.

**Clm 3 (currently amended).** Apparatus of claim 1, wherein the apparatus includes a means for stirring ~~[ensuring that]~~ secondary-water residing in the ~~[intermediate]~~ tank ~~[is mixed]~~.

**Clms 4-6 (cancel).**

**Clm 7 (currently amended).** Apparatus of claim 1, wherein the said respective conduits that convey secondary water:-

- [2] - from the ammonium-station-outlet into the ~~[intermediate]~~ tank;
- [3] - from the ~~[intermediate]~~ tank into the ammonium-station-inlet;
- [4] - from the electrolysis-station-outlet into the ~~[intermediate]~~ tank; and
- [5] - from the ~~[intermediate tank]~~ into the electrolysis-station-inlet;
- [6] are effective to so convey the secondary-water directly. ~~[in the sense that the secondary-water undergoes no substantial change of ammonium-concentration therebetween]~~

**Clm 8 (cancel).**

**Clm 9.** Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without itself being subjected to electrolysis.

**Clm 10.** Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without touching the body of secondary-water.

**Clm 11 (currently amended).** Apparatus of claim 1, wherein the apparatus is operable to circulate and recirculate the secondary-water through the electrolysis station. ~~[and the apparatus is operable to perform the electrolysis periodically, while the body of secondary water is recirculating through the ammonium-transfer station]~~

**Clm 12 (currently amended).** Apparatus of claim 1, wherein:

- (2) an ion-exchange station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;
- (3) the ion-exchange station includes a sorbent-container, in which is contained a sorbent-body, which is effective to sorb ammonium from water passing therethrough;
- (4) the secondary-water comprises regenerant-water, being water that contains, in solution, a regenerant-substance, which is of such nature, and of such concentration, as to have an ion-exchange relationship with respect to ammonium ions sorbed onto the sorbent-body, and wherein the secondary-water preferably is ~~(or includes,)~~ brine;
- (5) the ion-exchange station includes connecting conduits and operable flow-control valves therein;
- (6) the valves are operable to set the ion-exchange station into a sorption-mode and are operable to set the ion-exchange station into a regenerant-mode;
- (7) in the sorption-mode, the valves and conduits are arranged so that waste-water passes from the waste-water entry port, through the sorbent-container, and out of the treated-water discharge port; and
- (8) in the regenerant-mode, the valves and conduits are included in the secondary-water circuit, in which the regenerant-water, having passed through the sorbent-container, passes then through the electrolytic cell.

**Clm 13.** Apparatus of claim 12, wherein the secondary-water circuit is operable to recirculate the regenerant-water through the sorbent-container and the electrolytic cell.

**Clm 14.** Apparatus of claim 1, wherein:

- (2) an alkali-acid station of the apparatus combines the ammonium-extraction station and the ammonium-transfer station;
- (3) the body of secondary-water comprises a body of acid-water, and wherein the secondary-water preferably is, or includes, hydrochloric acid;
- (4) the alkali-acid station includes:
- (5) - a means for elevating the pH of ammonium-laden waste-water entering the waste-water entry port to at least ten;
- (6) - an alkali-station, comprising a waste-water conduit containing the alkaline waste-water and a gas conduit, and the alkali-station is so structured that ammonia gas emanating from the alkaline waste-water in the waste-water conduit is captured and carried away in the gas conduit;
- (7) - a means for maintaining the pH of the acid-water at no more than four;
- (8) - an acid-station, which includes the gas conduit and an acid-water conduit containing the acid-water, and the acid-station is so structured that ammonia gas contained in the gas conduit is taken into solution in the acid-water in the acid-water conduit;
- (9) and the secondary-water circuit includes the acid-water conduit, in which the acid-water, having passed through the acid-station, passes then through the electrolytic cell.

**Clm 15.** Apparatus of claim 14, wherein the secondary-water circuit is operable to recirculate the acid-water through the acid-station and the electrolytic cell.

**Clm 16.** Water treatment plant, for treating both a lower-flowrate stream of higher-concentration waste-water and a higher-flowrate stream of lower-concentration waste-water, wherein:

- (2) the plant is operable to pass the lower-concentration stream through the ion-exchange station of claim 12, and the higher-concentration stream through the alkali-acid station of claim 14;
- (3) and the plant is operable to mix the treated waste-water effluent from the alkali-acid station with the waste-water stream entering and passing through the ion-exchange station.

**Clm 17 (cancel).**

**Clm 18 (currently amended).** Apparatus for diminishing the concentration of ammonium in a body of secondary-water, and for disposing of the ammonium as nitrogen gas, wherein:

- (2) the apparatus includes a body of secondary-water;
- (3) the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
- (4) the apparatus includes an ammonium station, which is one of the components of the secondary-water circuit;

- [5] the apparatus is so arranged that ammonium is added to secondary-water passing through the ammonium station;  
[6] the apparatus includes an electrolysis station, which is one of the components of the secondary-water circuit ;  
[7] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-  
[8] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;  
[9] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;  
[10] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station;  
[11] the apparatus includes ~~[an intermediate tank]~~ a tank, which is one of the components of the secondary-water-circuit;  
[12] the ammonium station has an ammonium-station-inlet and an ammonium-station-outlet, through which secondary-water  
respectively enters and leaves the ammonium-station;  
[13] the electrolysis station has an electrolysis-station-inlet and an electrolysis-station-outlet, through which secondary-water  
enters and leaves the electrolysis-station;  
[14] the ammonium station is so configured that secondary-water in the ammonium-station-outlet is at a higher concentration of  
dissolved ammonium than secondary-water in the ammonium-station-inlet;  
[15] ~~the electrolysis station has an electrolysis station inlet and an electrolysis station outlet, through which secondary water  
respectively enters and leaves the electrolysis station;~~  
[16] the electrolysis station is so configured that secondary water in the electrolysis-station-outlet is at a lower concentration of  
dissolved ammonium than secondary-water in the electrolysis-station-inlet;  
[17] the secondary-water circuit includes respective conduits that convey secondary water:-  
[18] - from the ammonium-station-outlet into the ~~[intermediate]~~ tank;  
[19] - from the ~~[intermediate]~~ tank into the ammonium-station-inlet;  
[20] - from the electrolysis-station-outlet into the ~~[intermediate]~~ tank; and  
[21] - from the ~~[intermediate]~~ tank into the electrolysis-station-inlet.

Clm 19 (currently amended). Apparatus of claim 18, wherein the body of secondary-water is ~~(or includes,)~~ brine.

Clm 20. Apparatus of claim 18, wherein the body of secondary water is, or includes, hydrochloric acid.